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CONFIDENTIAL

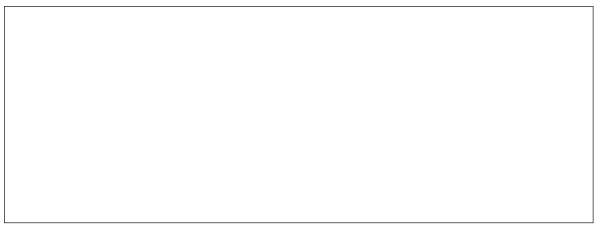
17 May 57

Container, Underwater Storage
EB 177A

PANEL

TESTS

25X1



25X1

May 17, 1957

Dear Sir:

This letter report summarizes the results of the inspection of the unpainted-metal test panels which were immersed in sea water at Daytona Beach, for 12 months, during the period from February, 1956, to April, 1957, in connection with Research Order No. 16. The four- and six-month inspection data on these panels were described in our letter report dated September 20, 1956.

Based on the results of the first-year inspection, the following tentative conclusions can be drawn:

(1) Wrought titanium could withstand this type of exposure successfully for 5 years.

(2) Cast aluminum alloys 43 and 356-T6 could be used successfully on containers to be submerged for 5 years.

(3) Wrought 52S aluminum alloy, not anodized, would probably withstand 5 years of immersion whether welded or not.

(4) Wrought 52S aluminum alloy, anodized, would probably withstand 5 years of immersion if not welded, but welding would probably induce corrosion failure.

(5) Types 316 and 304 stainless steel would not withstand 5 years of immersion.

(6) Monel would not withstand 5 years of immersion.

With the exception of cast Alloy 43 and the Alloy 356-T6, the various materials had been exposed in the form of 0.062" x 6" x 12" panels. The Alloy 43 and Alloy 356-T6 specimens were 1/2" x 2" x 12".

A preliminary inspection of the specimens was made at our North Florida Research Station before they were shipped to Columbus for a detailed inspection. In the course of this preliminary inspection, the specimens were examined from the standpoint of fouling. Then, to permit observation of any corrosion that may have occurred, half of each face of each test specimen was cleaned of all fouling with a wooden block or scraper. The remaining surface of each specimen was left undisturbed. The results of the preliminary inspection are given in Table 1.

After receiving the specimens from Daytona Beach, we cleaned them chemically to remove all of the fouling, and then examined them specifically for corrosion damage. Table 2 summarizes the results of this detailed inspection.

After completing this detailed inspection of the panels, we photographed both sides of each panel. Figures 1 through 28 show the detailed evidence of corrosion after 12 months of sea-water immersion. It will be noted that most of the panels exhibit rather severe corrosion damage within the first inch of each end; these areas of accelerated corrosion were omitted from the inspection because they represent the portions of the panels that were clamped in the test racks during immersion. Because of the difficulties involved in showing the corrosion damage photographically, selected features of the specimens are called out in the caption for each photograph. Care

TABLE 1. RESULTS OF PRELIMINARY INSPECTION OF UNPAINTED-METAL PANELS AFTER 12-MONTH IMMERSION IN SEA WATER

Specimen No.	Description	Comments
10	Bare 52S	Fouling heavy; mottled bronze-brown discoloration over most of panel; no definite evidence of corrosion pitting.
10W	Bare 52S with weld bead	Same as No. 10; no effects noted at weld.
20	Anodized 52S	Fouling heavy; mottled bronze-brown discoloration over most of panel; two small pits observed.
20W	Anodized 52S with weld bead	Fouling heavy; mottled bronze-brown discoloration over most of panel; severe pitting throughout the cleaned lower half of panel; weld-bead side showed considerable pitting.
30	Type 316	Fouling heavy; rust-colored discoloration noted throughout the cleaned lower half of panel; no pitting observed.
30W	Type 316 with weld bead	Similar to No. 30; however metal was etched under two barnacle bases; also one large pit noted in a spot of intense rust-colored discoloration; two other minute pits noted; weld apparently intact.
40	Type 304	Fouling heavy; no discoloration noted; three 1/4- to 1/2-inch-diameter areas of etching and pitting observed; these areas seemed to be located under barnacle bases.
40W	Type 304 with weld bead	Similar to No. 40; four areas of etching and pitting noted; weld generally intact.
50	Monel	Fouling relatively light; numerous spots of green corrosion product scattered over entire panel, with deep pits under most of these spots; severe pitting throughout.
50W	Monel with weld bead	Similar to No. 50; severe pitting also noted on and around lower half of weld.

TABLE 1. (Continued)

Specimen No.	Description	Comments
60	Titanium	Fouling heavy; rust-brown stain mottled throughout; no definite evidence of corrosion.
60W	Titanium with weld bead	Similar to No. 60; no effects at weld.
-	Cast 43	Fouling medium; uniform surface etching over both specimens, with a few small pits.
-	356-T6	Fouling medium; uniform surface etching over both specimens, with a few small pits.

TABLE 2. RESULTS OF CORROSION INSPECTION OF UNPAINTED-METAL PANELS AFTER 12-MONTH IMMERSION IN SEA WATER*

Specimen No.	Description	Comments
10	Bare 52S	One pit 0.004 inch deep; otherwise, only very minor pitting.
10W	Bare 52S with weld bead	All pitting very minor.
20	Anodized 52S	23 pits ranging from 0.002 to 0.004 inch deep; remainder of pitting minor.
20W	Anodized 52S with weld bead	Very heavy pitting, especially in area of weld bead; pits ranged from 0.002 to 0.031 inch deep.
30	Type 316	Five major localized pits ranging from 0.019 to 0.032 inch deep; numerous small pinhole pits.
30W	Type 316 with weld bead	One large pit 0.060 inch deep; 25 others ranging from 0.0005 to 0.015 inch deep; numerous pinhole pits.
40	Type 304	Three areas where pitting penetrated completely through panel; 23 other pits ranging from 0.008 to 0.056 inch deep; numerous pinhole pits.
40W	Type 304 with weld bead	One pit completely through panel; 31 pits ranging from 0.004 to 0.042 inch deep; numerous pinhole pits.
50	Monel	Pitted very badly; surface approximately 70 per cent pitted; panel considered failed.
50W	Monel with weld bead	Same as No. 50.
60	Titanium	No sign of any corrosion damage.
60W	Titanium with weld bead	No sign of any corrosion damage.
-	Cast 43	Only minor pitting.
-	356-T6	Only minor pitting.

Note: See Figures 1 through 28.

*The panels were cleaned chemically prior to the inspection.

must be taken in interpreting the corrosion damage as indicated by these photographs alone.

Future work with regard to the duplicate unpainted metal specimens which are still under exposure to sea water will consist of continuing the immersion testing and then conducting an inspection after an additional 12-month period. In view of the current expiration date of the Research Order No. 16 contract, the above-indicated activity will be performed under another contractual arrangement. As discussed during your recent visit on May 2, 1957, a request will be presented to your Contracting Officer for an appropriate change in the scope of Task Order No. G.

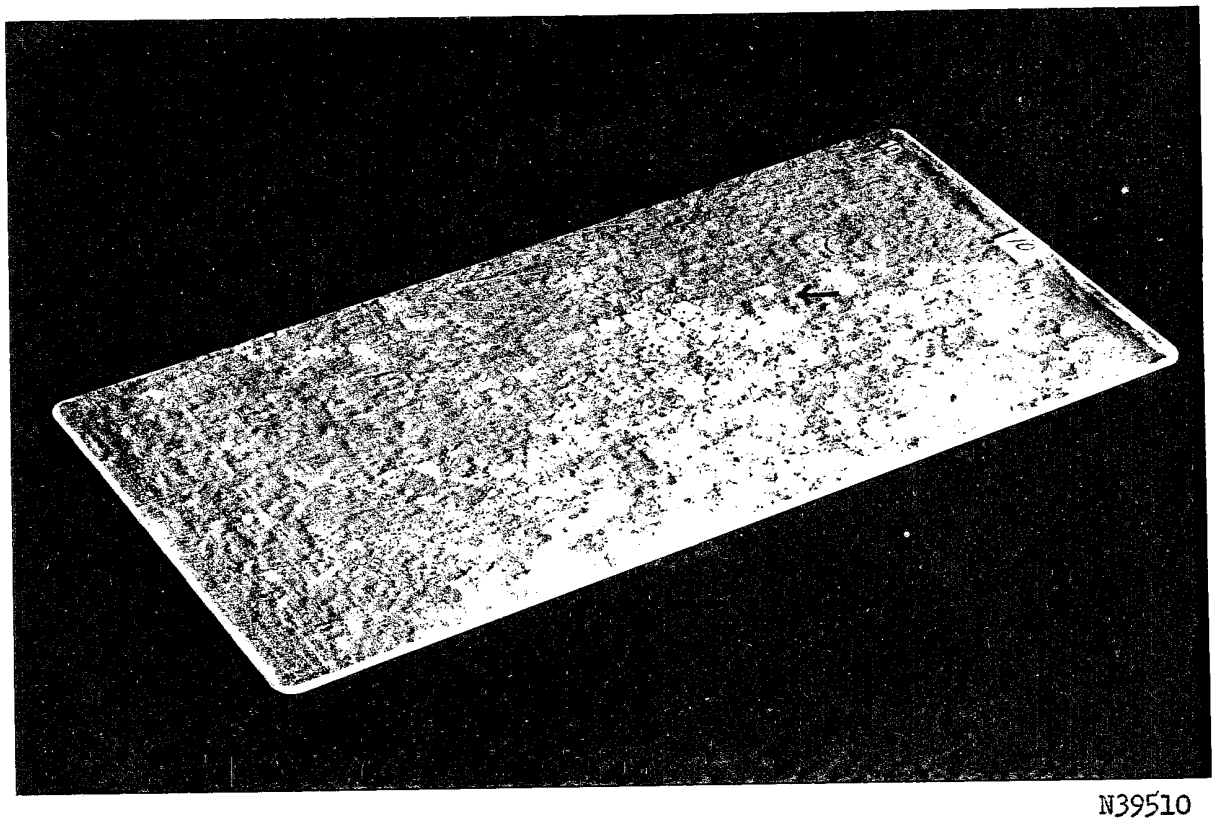
The total appropriation on Research Order No. 16 was $45,959. As of May 1, 1957, the unexpended balance was approximately $250.

Sincerely,

[redacted] 25X1

ABW:vh

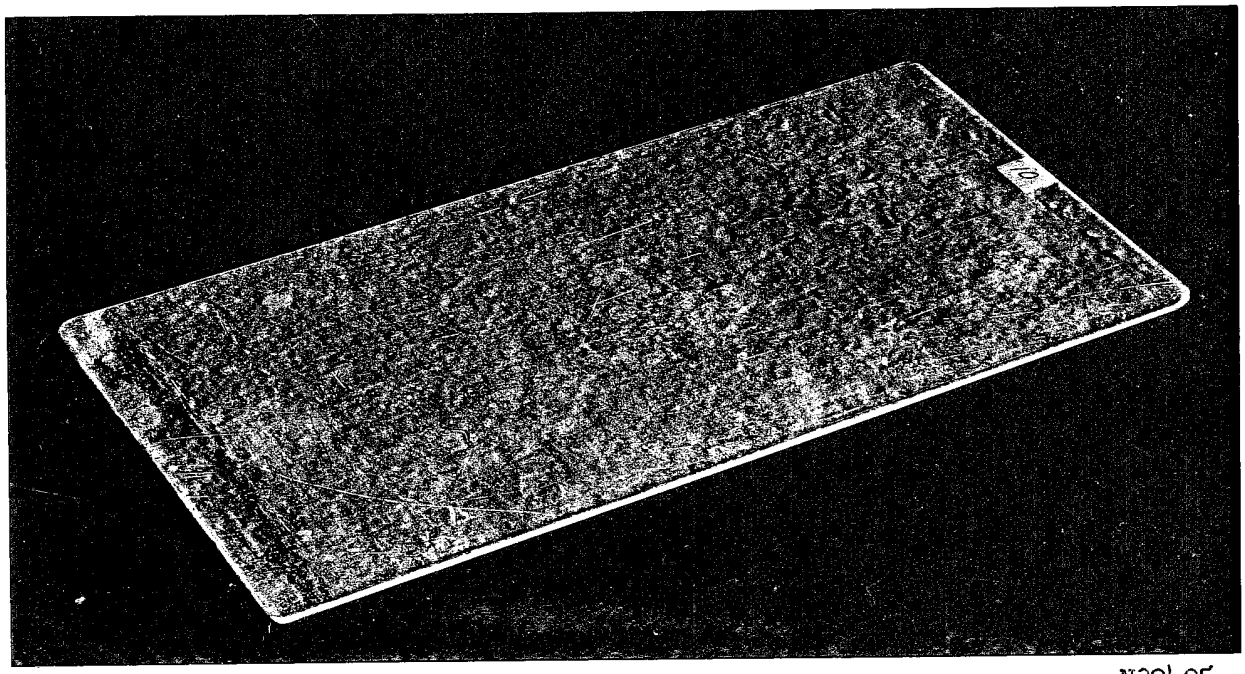
In Duplicate



N39510

Figure 1. Front Side of Bare Type 52S Panel (No. 10) - 12 Months of Sea-Water Immersion

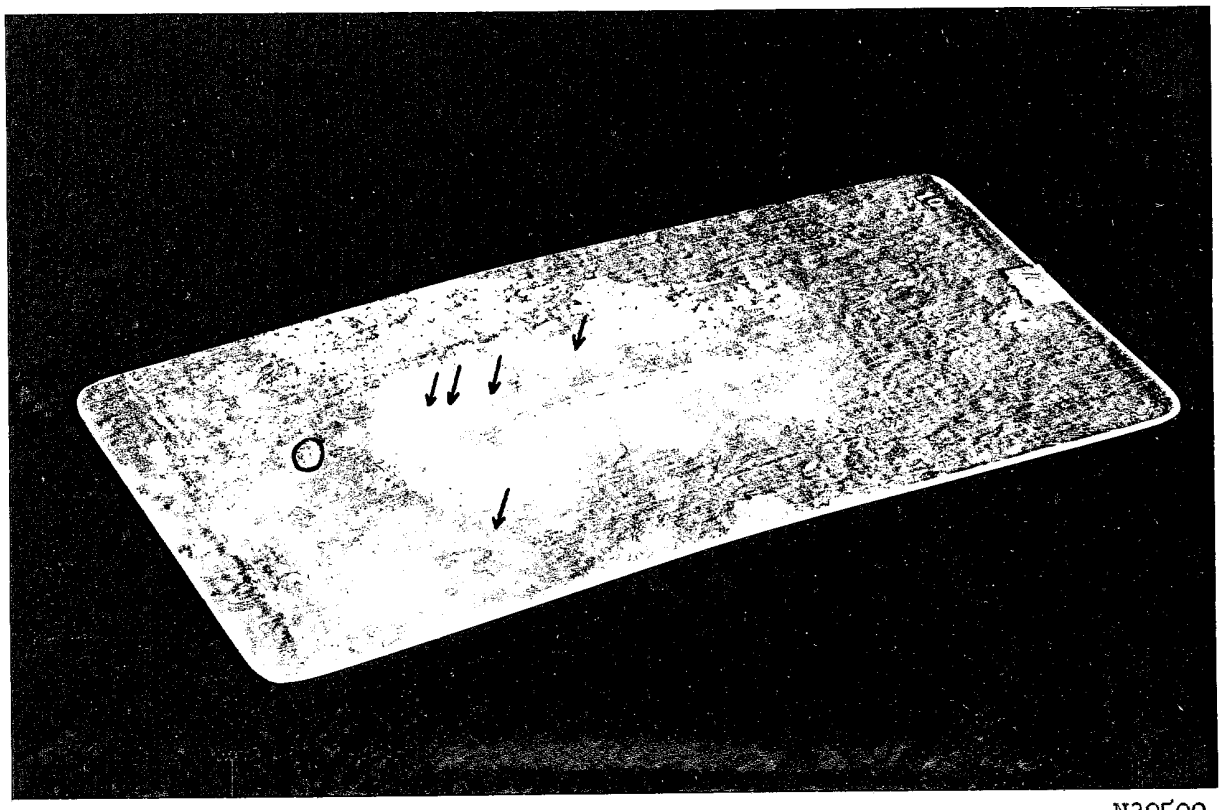
Light spot shown by arrow is area of deepest corrosion penetration - approximately 0.004 inch deep.



N39495

Figure 2. Back Side of Bare Type 52S Panel (No. 10) - 12 Months of Sea-Water Immersion

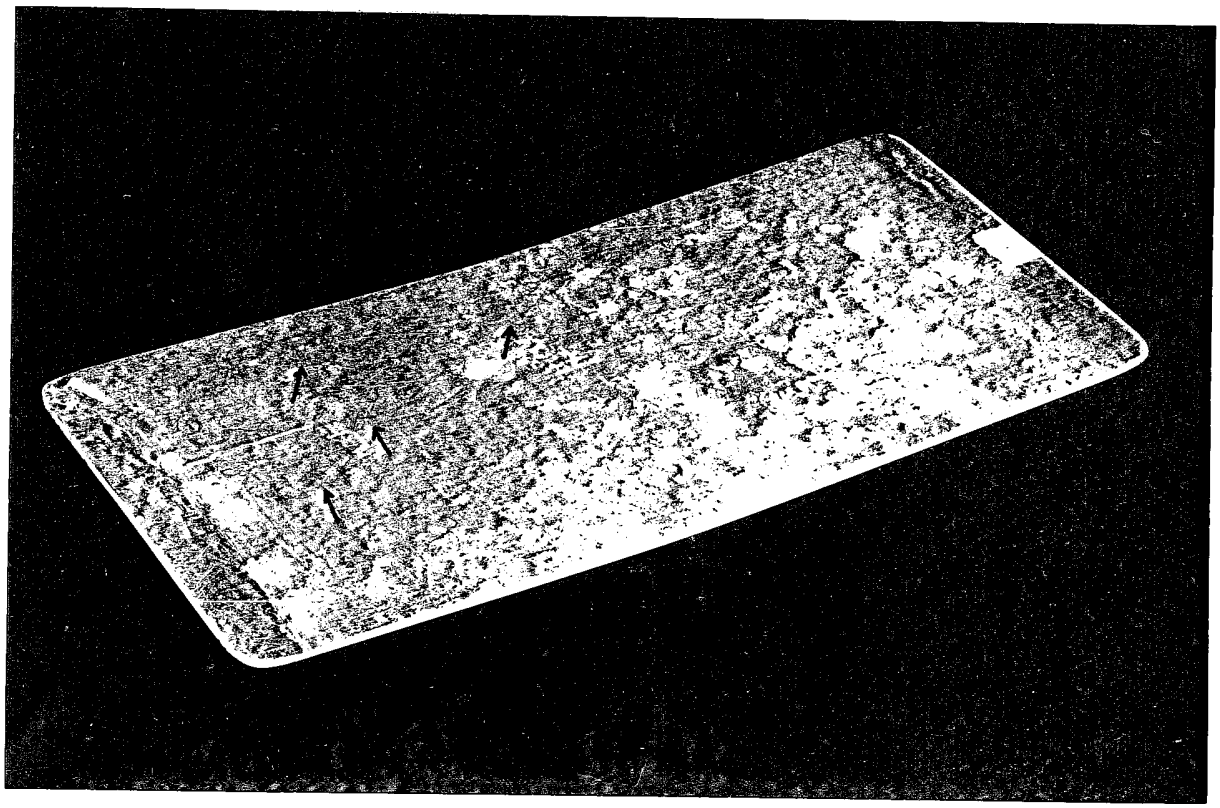
Scattered very light areas are minor pinhole pits.



N39509

Figure 3. Front Side of Bare Type 52S Panel With Weld Bead (No. 10W) - 12 Months of Sea-Water Immersion

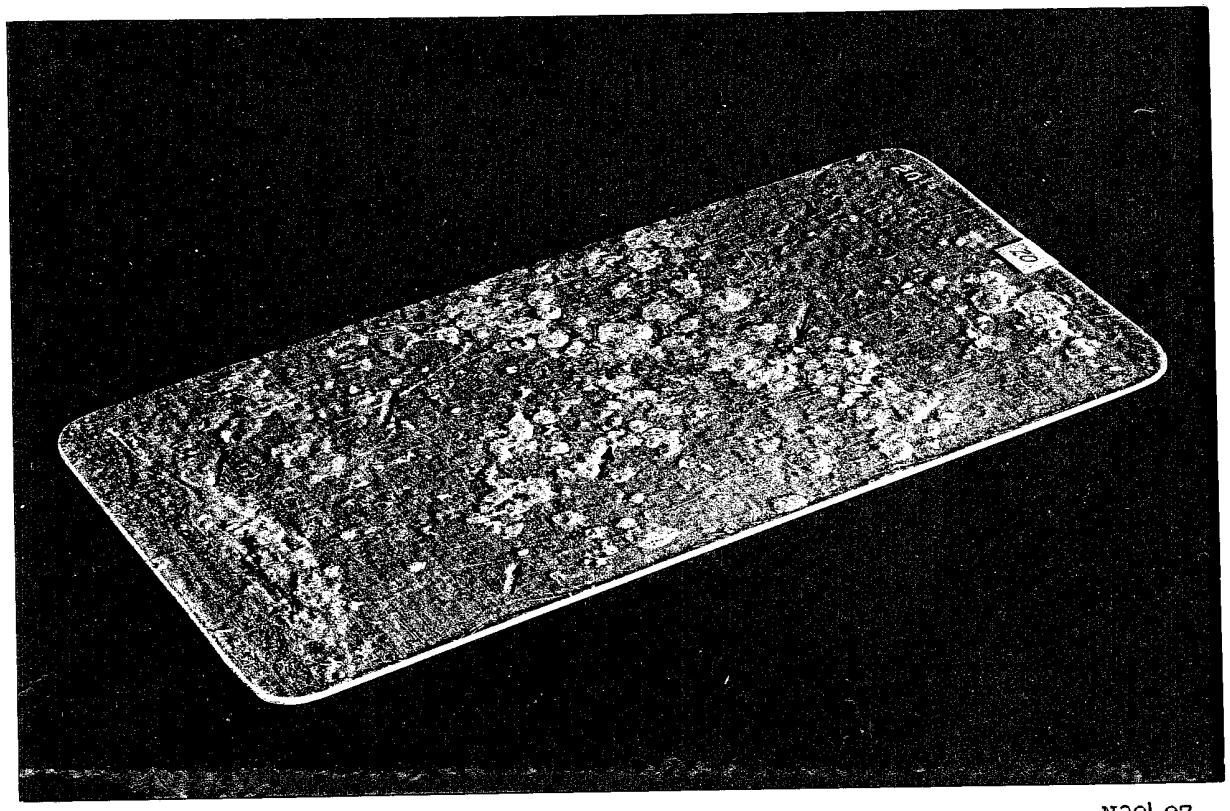
Light areas shown by arrows are shallow corrosion pits. (Circled area is scratch in the metal.)



N39512

Figure 4. Back Side of Bare Type 52S Panel With Weld Bead (No. 10W) - 12 Months of Sea-Water Immersion

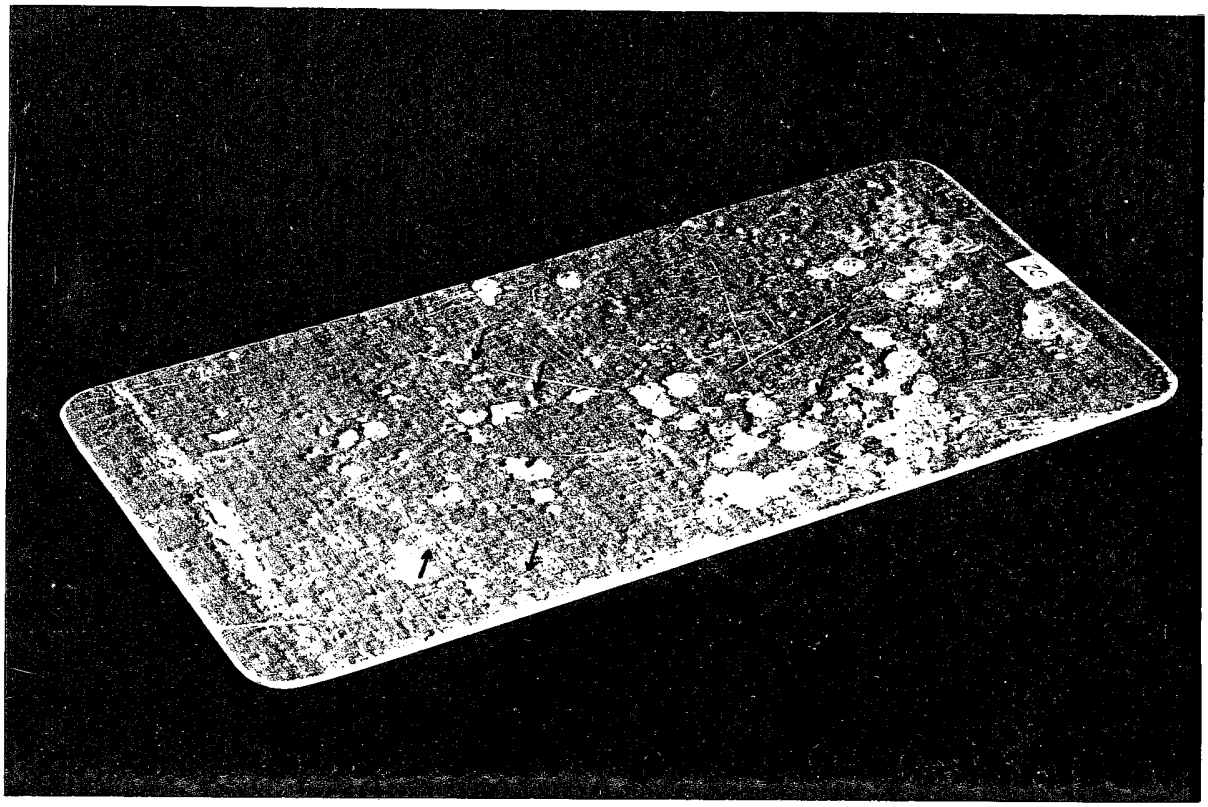
Pitting is very minor. A few pinpoint pits are indicated by arrows.



N39497

Figure 5. Front Side of Anodized Type 52S Panel (No. 20) - 12 Months of Sea-Water Immersion

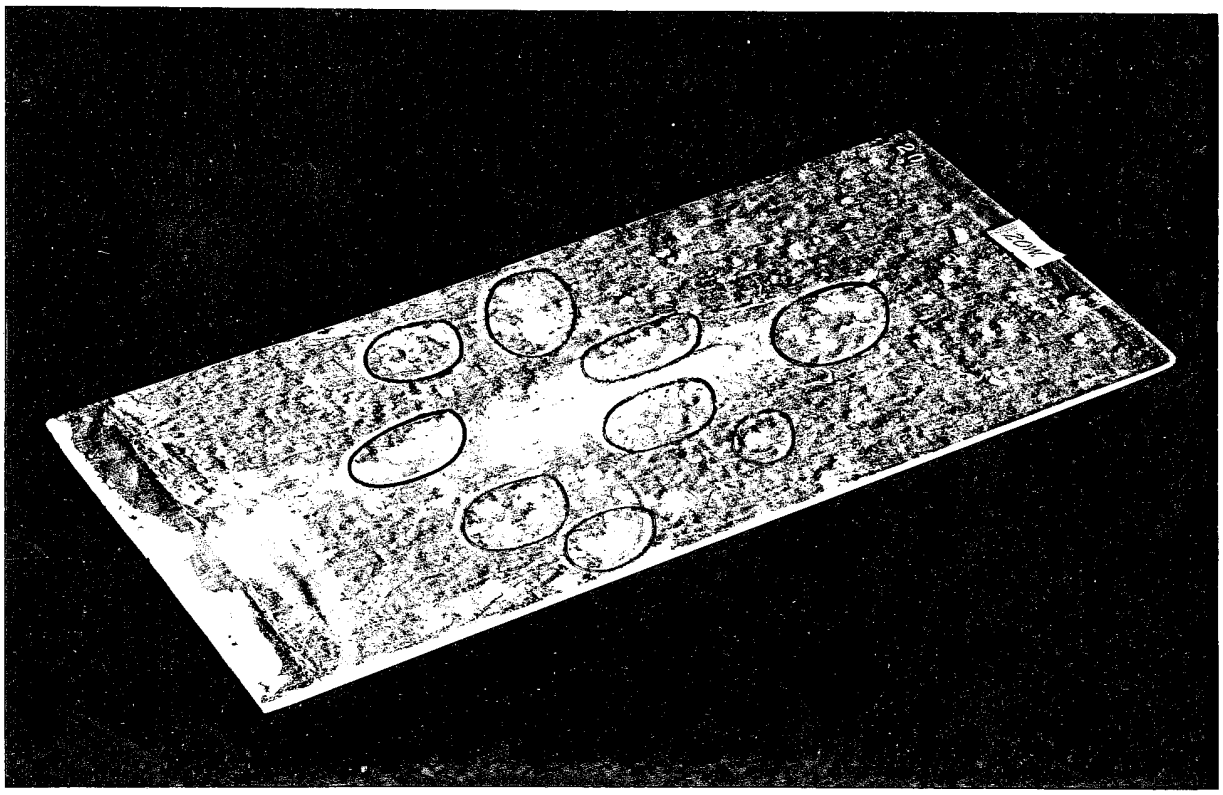
Major pits are indicated by arrows - maximum depth 0.004 inch.



N39511

Figure 6. Back Side of Anodized Type 52S Panel (No. 20) - 12 Months of Sea-Water Immersion

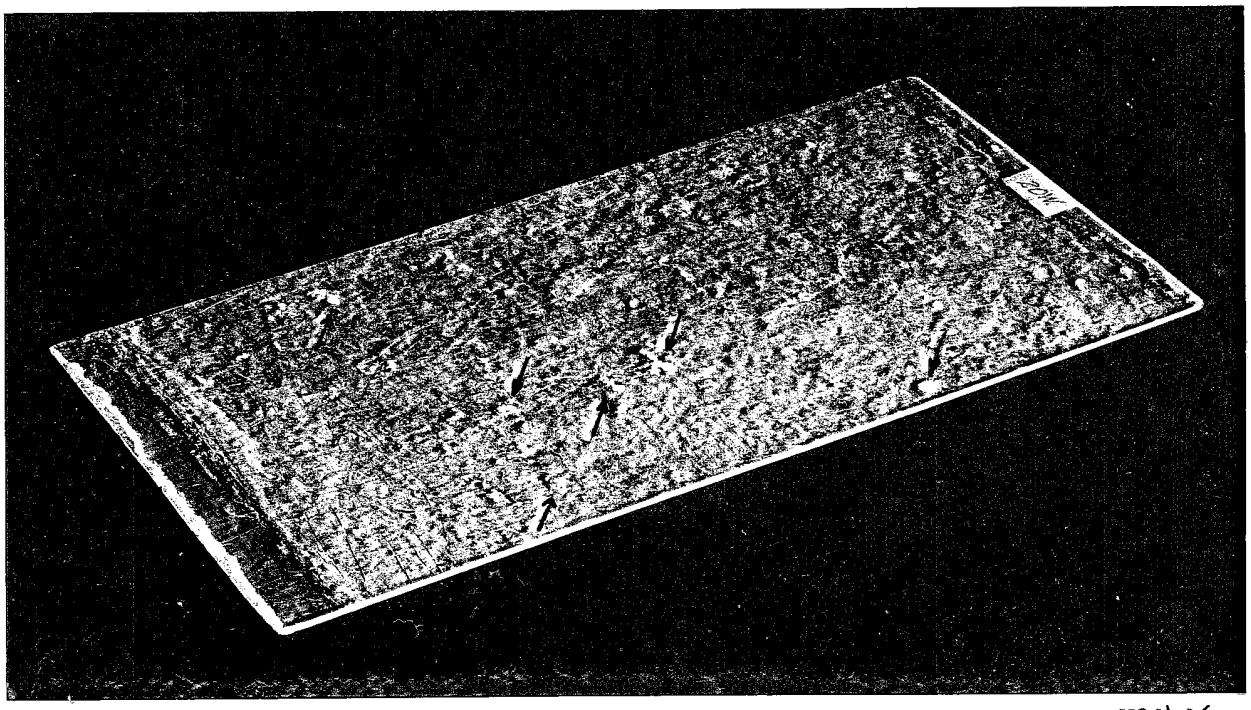
Major pits are indicated by arrows - maximum depth 0.004 inch.



N39508

Figure 7. Front Side of Anodized Type 52S Panel With Weld Bead (No. 20W) - 12 Months of Sea-Water Immersion

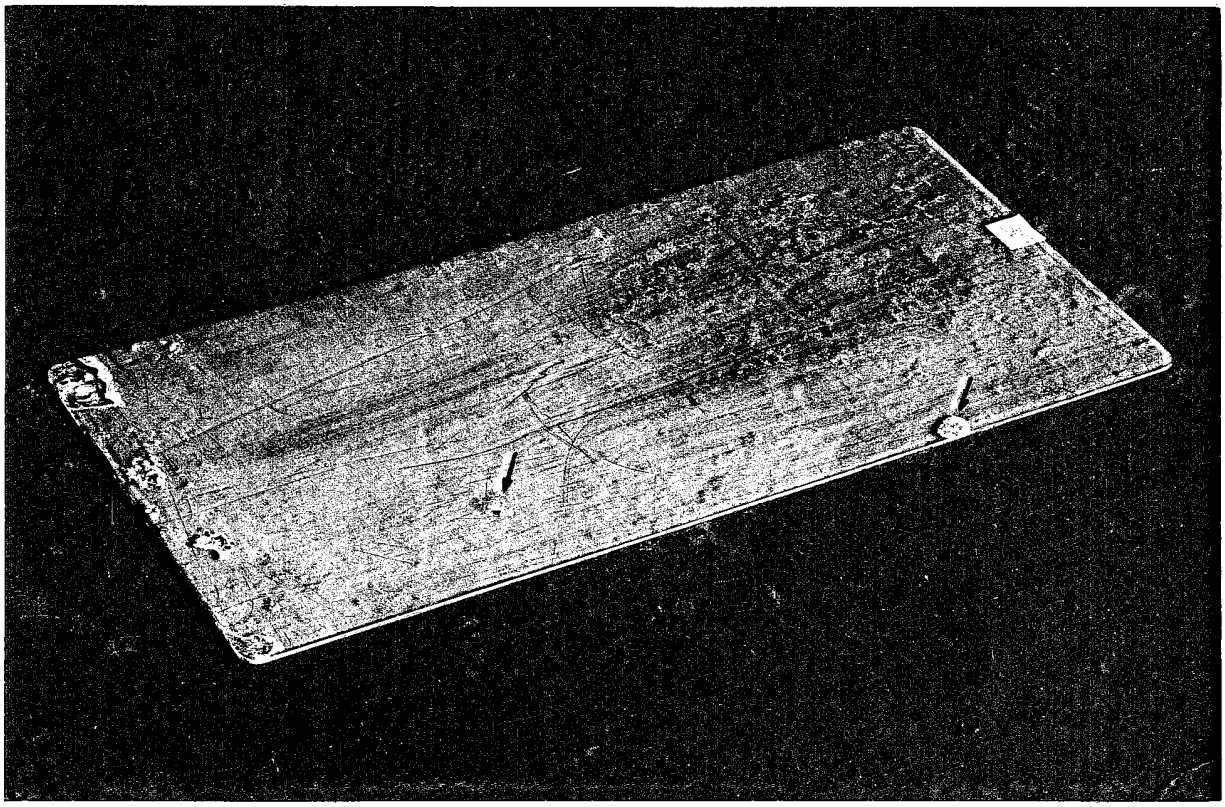
Panel is badly pitted in areas indicated by circles. Maximum pit depth is 0.031 inch.



N39496

Figure 8. Back Side of Anodized Type 52S Panel With Weld Bead (No. 20W) - 12 Months of Sea-Water Immersion

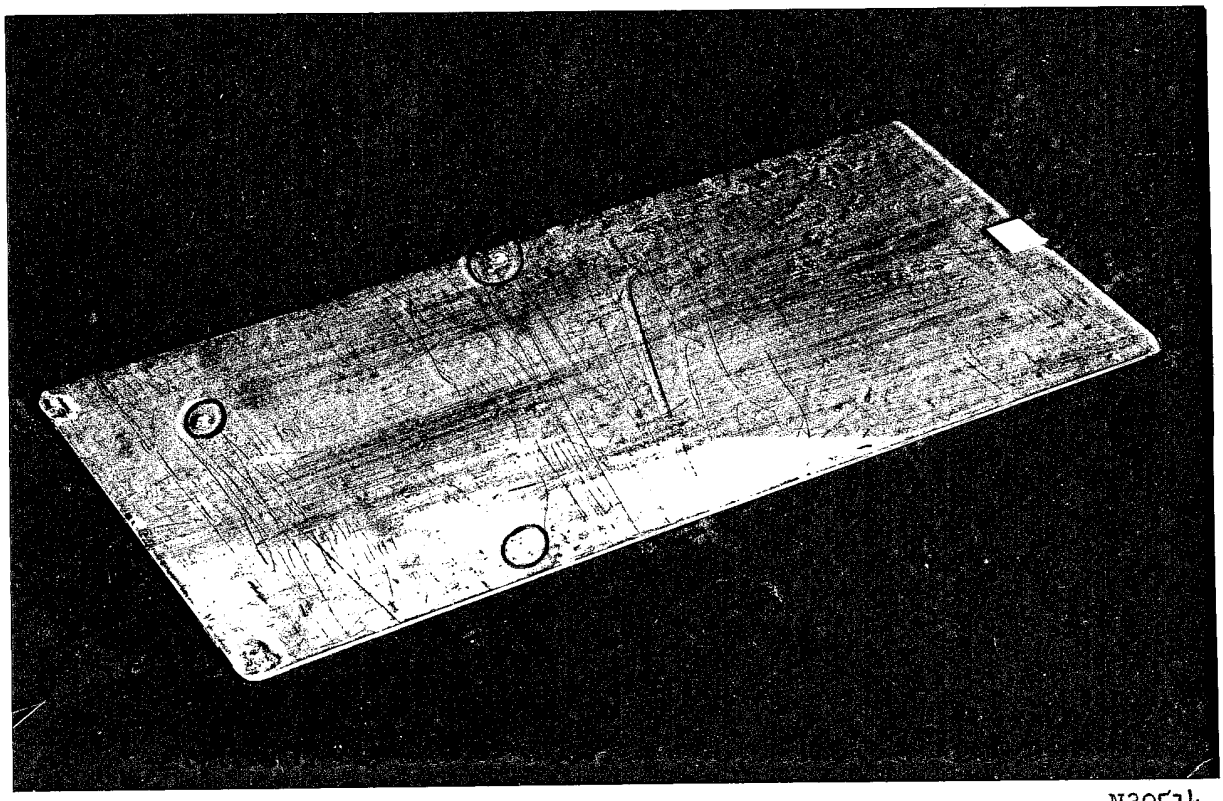
Arrows indicate major pits - 0.004 to 0.031 inch deep.



N39513

Figure 9. Front Side of Type 316 Panel (No. 30) - 12 Months of Sea-Water Immersion

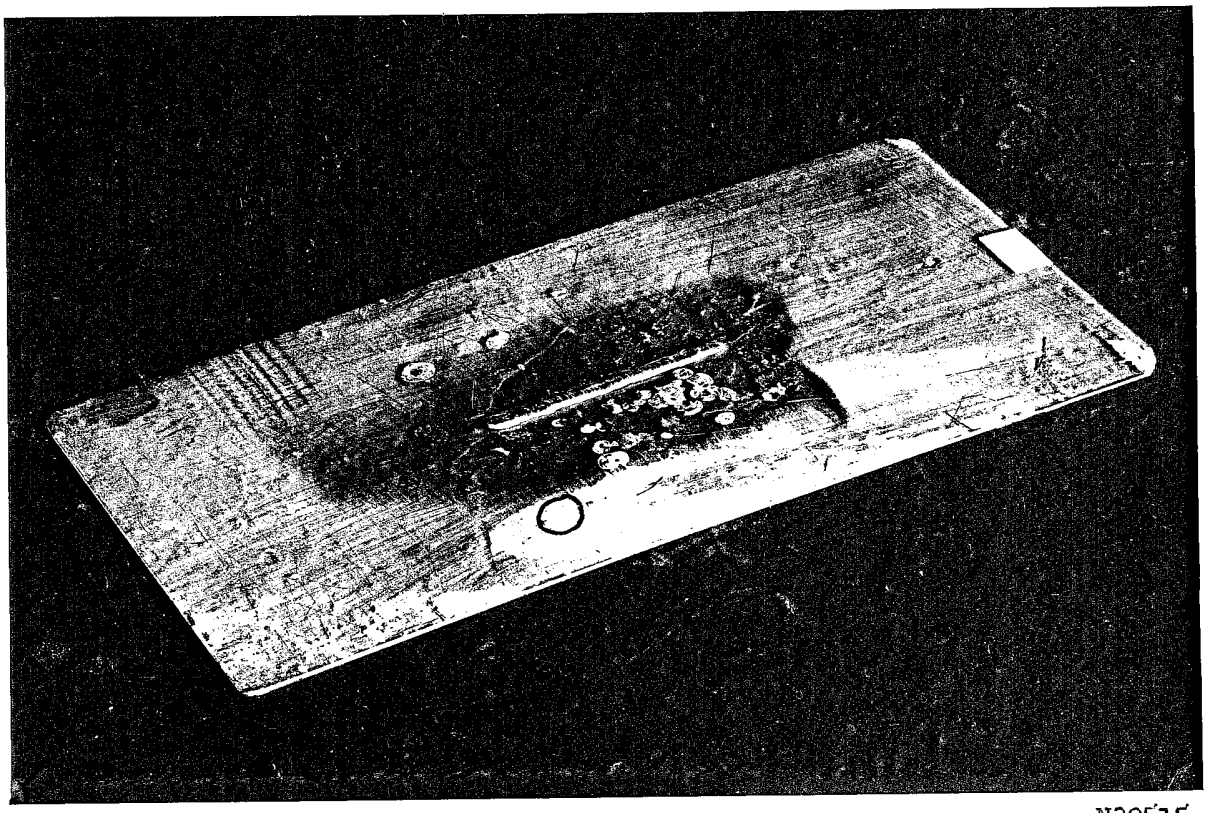
Two major pits were noted and are indicated by arrows. Mass of pinhole pits, in a pattern, is evident on right half of panel.



N39514

Figure 10. Back Side of Type 316 Panel (No. 30) - 12 Months of Sea-Water Immersion

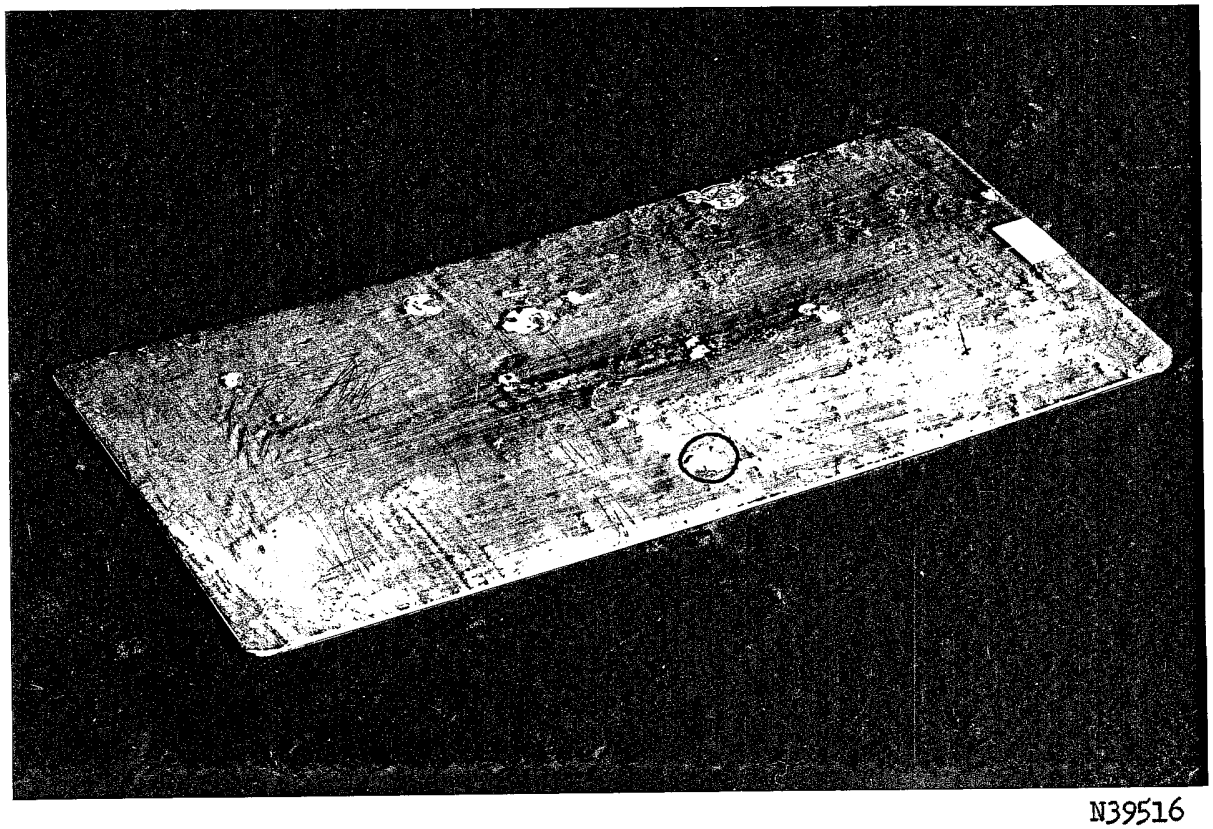
Three major pits are circled. A number of pinhole pits are evident at top of panel, along far edge. Major pits are 0.019 to 0.032 inch deep.



N39515

Figure 11. Front Side of Type 316 Panel With Weld Bead (No. 30W) - 12 Months of Sea-Water Immersion

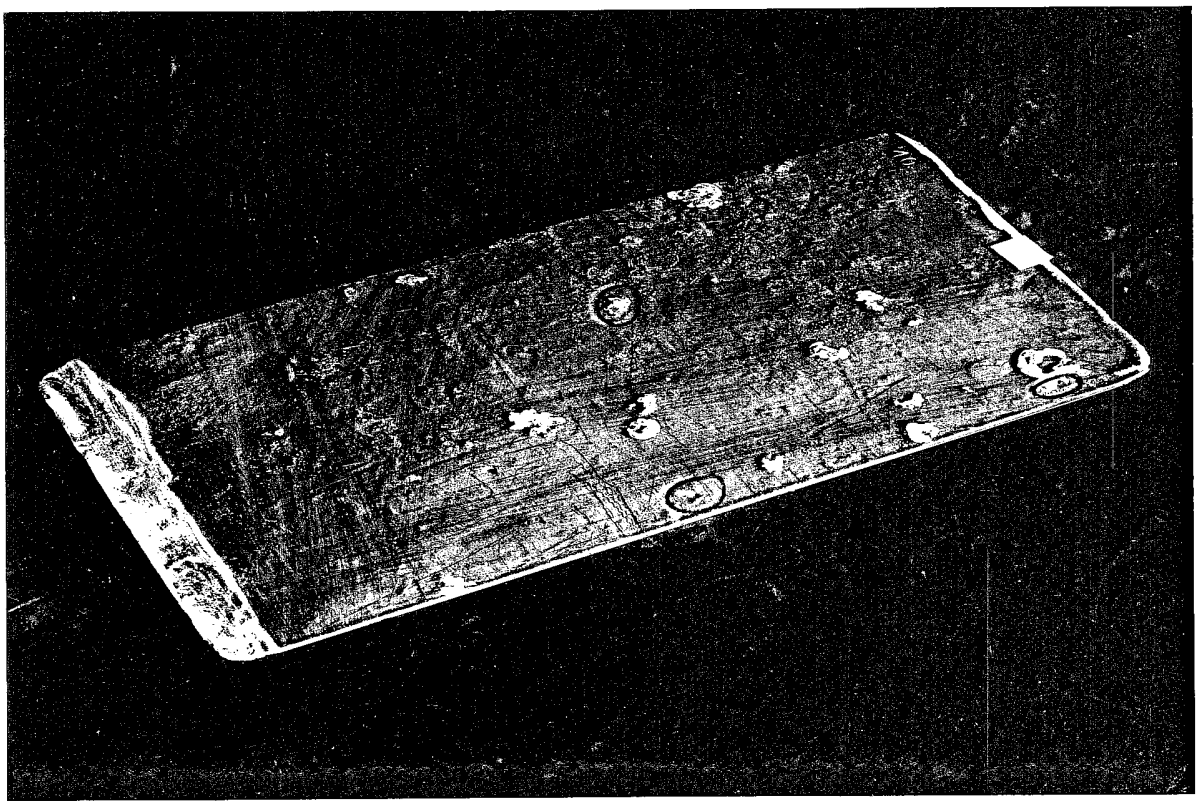
Circled pit is 0.015 inch deep. Other pits are from 0.0005 to 0.0025 inch deep.



N39516

Figure 12. Back Side of Type 316 Panel With Weld Bead (No. 30W) - 12 Months of Sea-Water Immersion

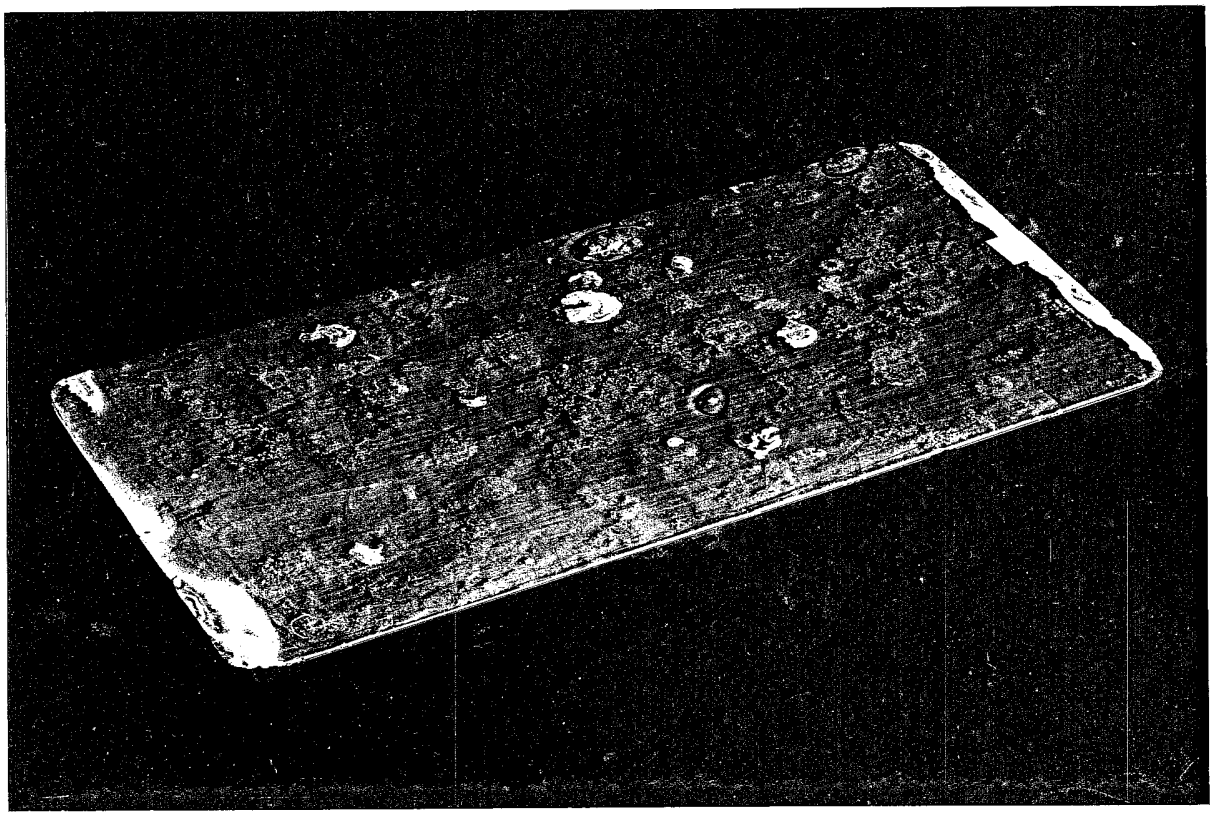
Circled pit is 0.060 inch deep - almost through panel. Other pits are 0.001 to 0.010 inch deep.



N39517

Figure 13. Front Side of Type 304 Panel (No. 40) - 12 Months of Sea-Water Immersion

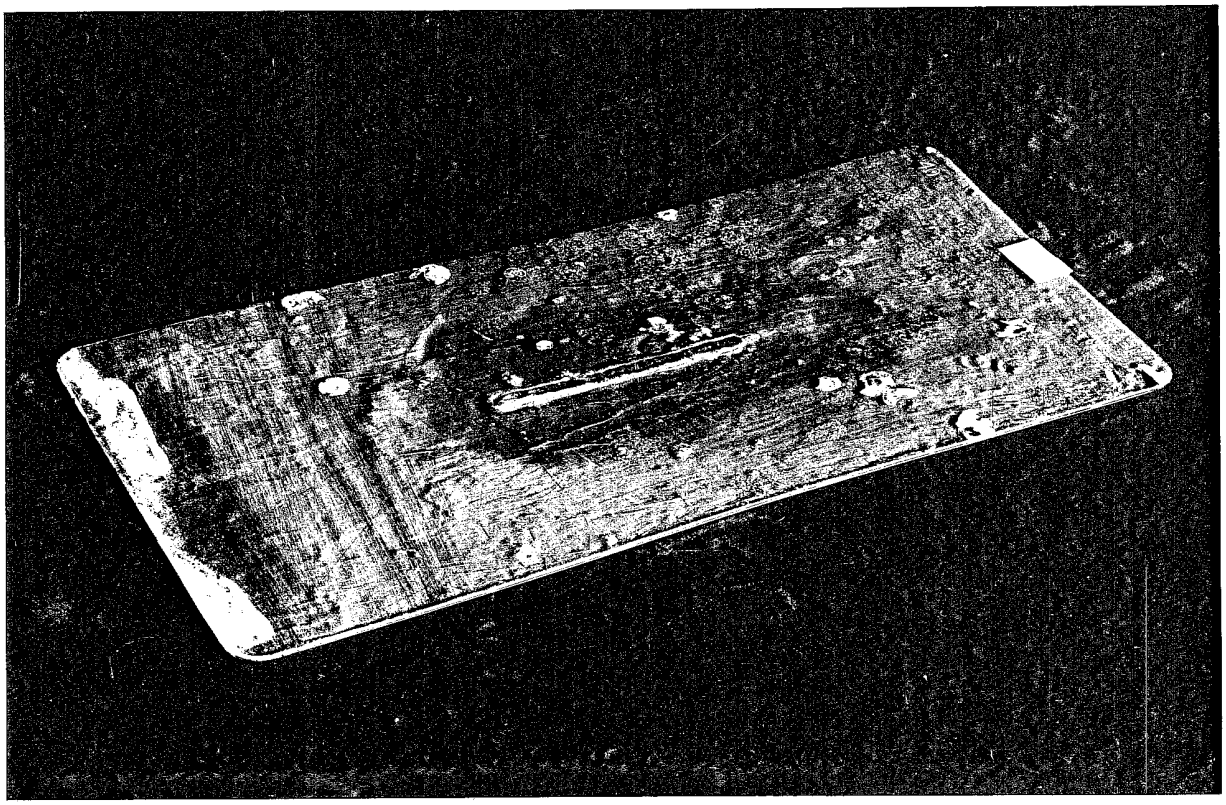
Circled areas show pitting that perforated the panel. In other areas pits are 0.008 to 0.056 inch deep. Note also a number of pinhole pits.



N39518

Figure 14. Back Side of Type 304 Panel (No. 40) - 12 Months of Sea-Water Immersion

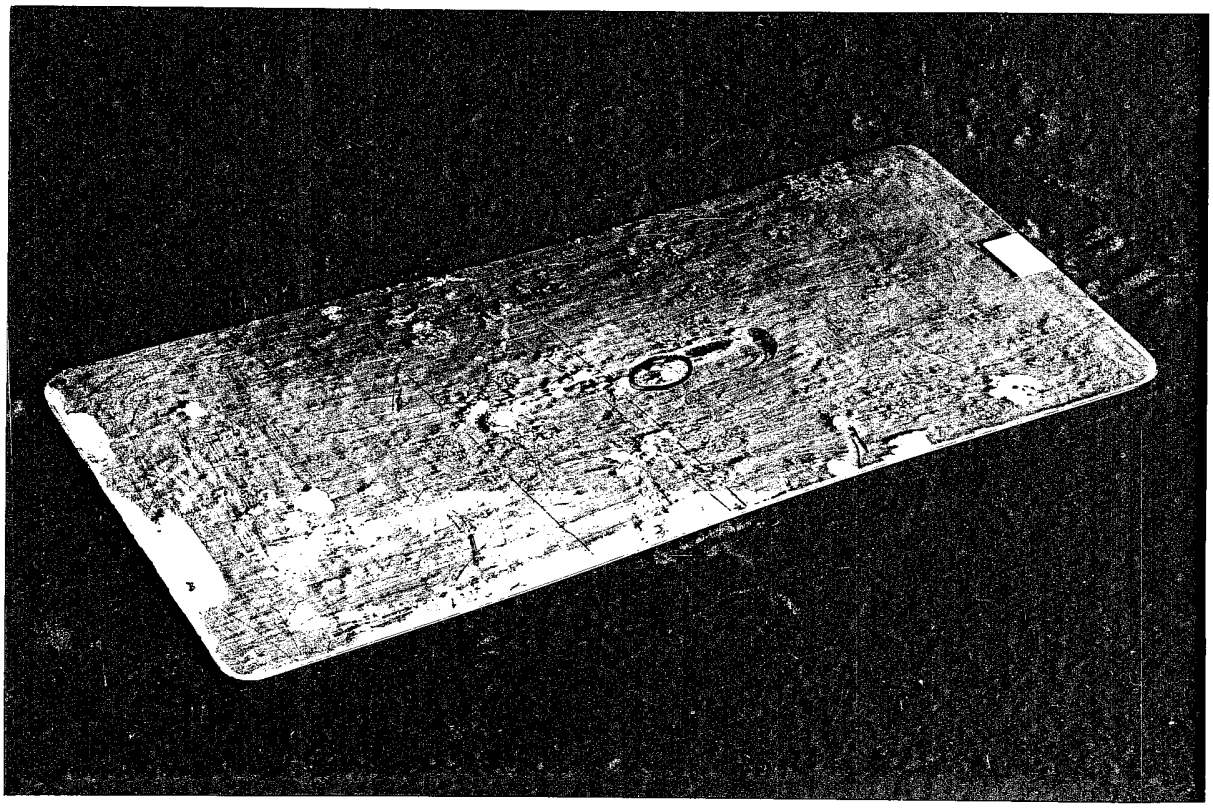
A few pits, in circled areas, perforated the panel. Other pits are 0.008 to 0.056 inch deep.



N39503

Figure 15. Front Side of Type 304 Panel With Weld Bead (No. 40W) - 12 Months of Sea-Water Immersion

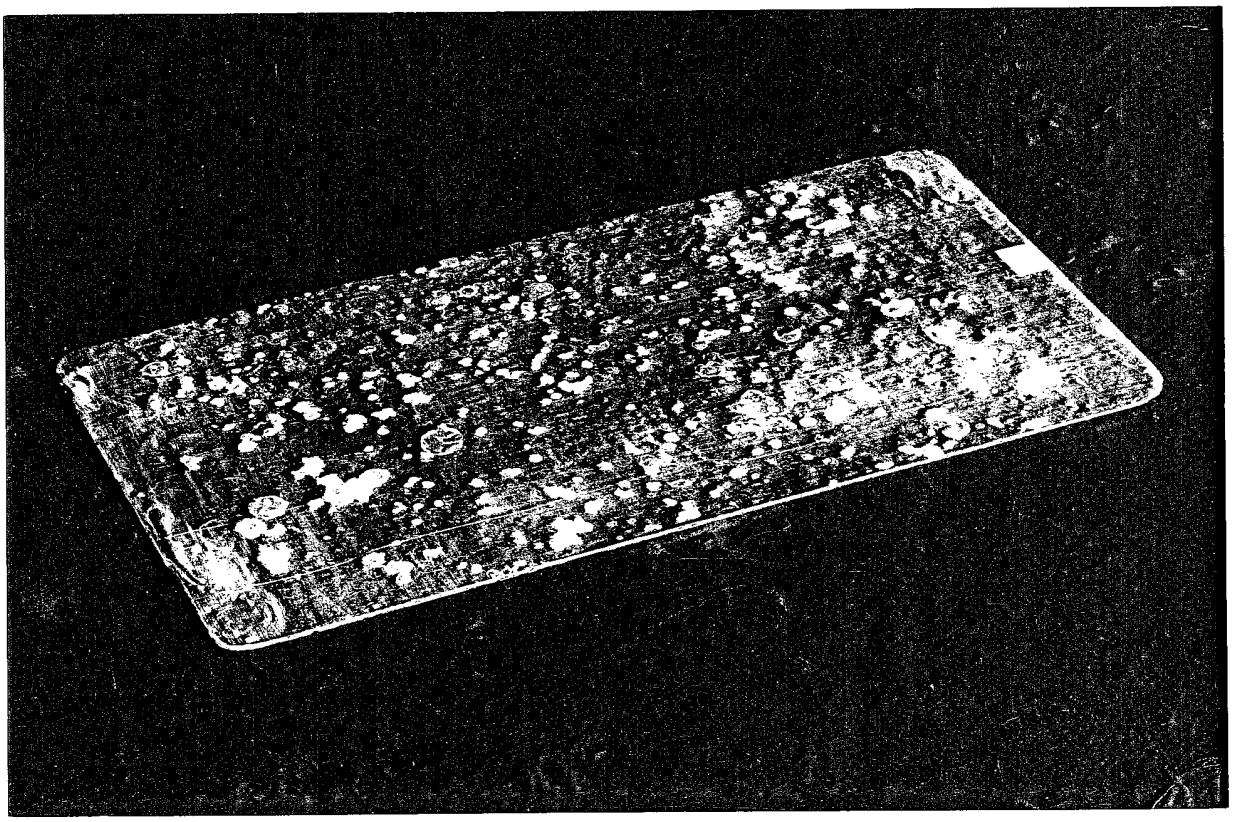
One pit, in circled area, perforated the panel. Other pits are 0.004 to 0.042 inch deep.



N39502

Figure 16. Back Side of Type 304 Panel With Weld Bead (No. 40W) - 12 Months of Sea-Water Immersion

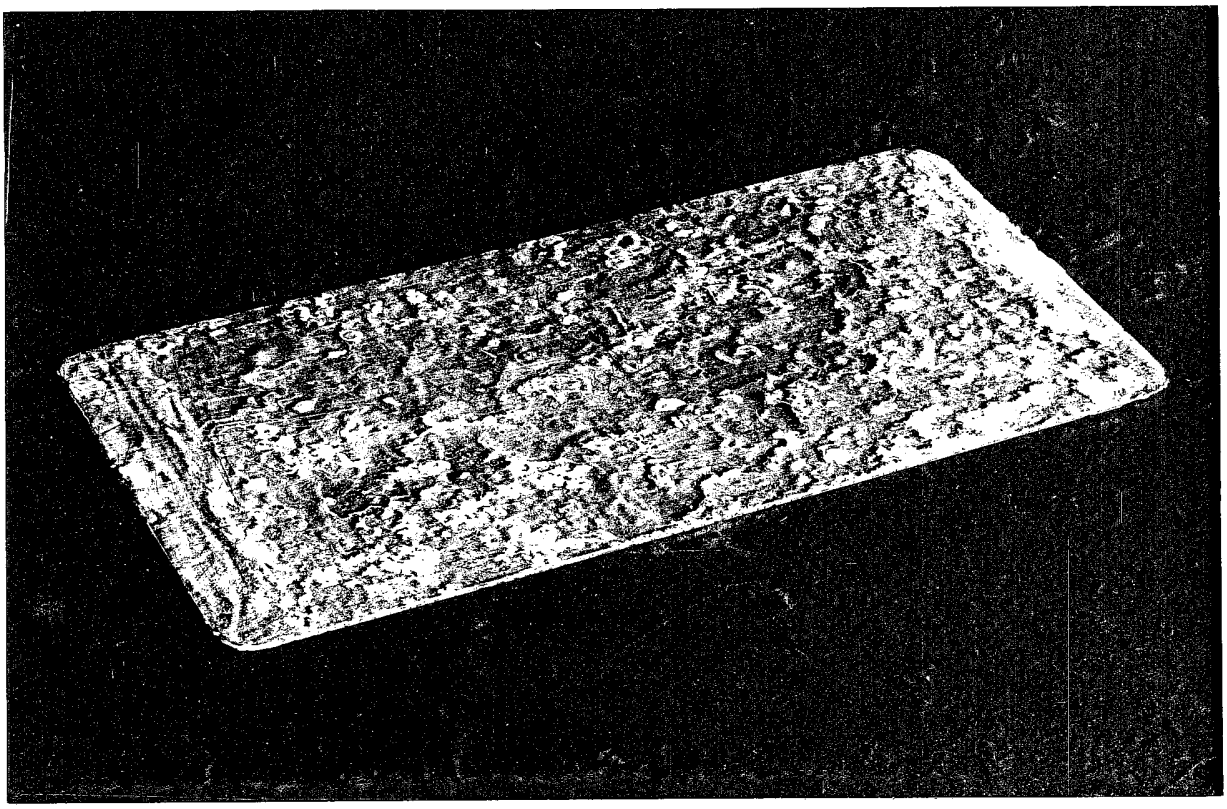
One pit, in circled area, perforated the panel. Other pits are 0.004 to 0.042 inch deep.



N39507

Figure 17. Front Side of Monel Panel (No. 50) - 12 Months of Sea-Water Immersion

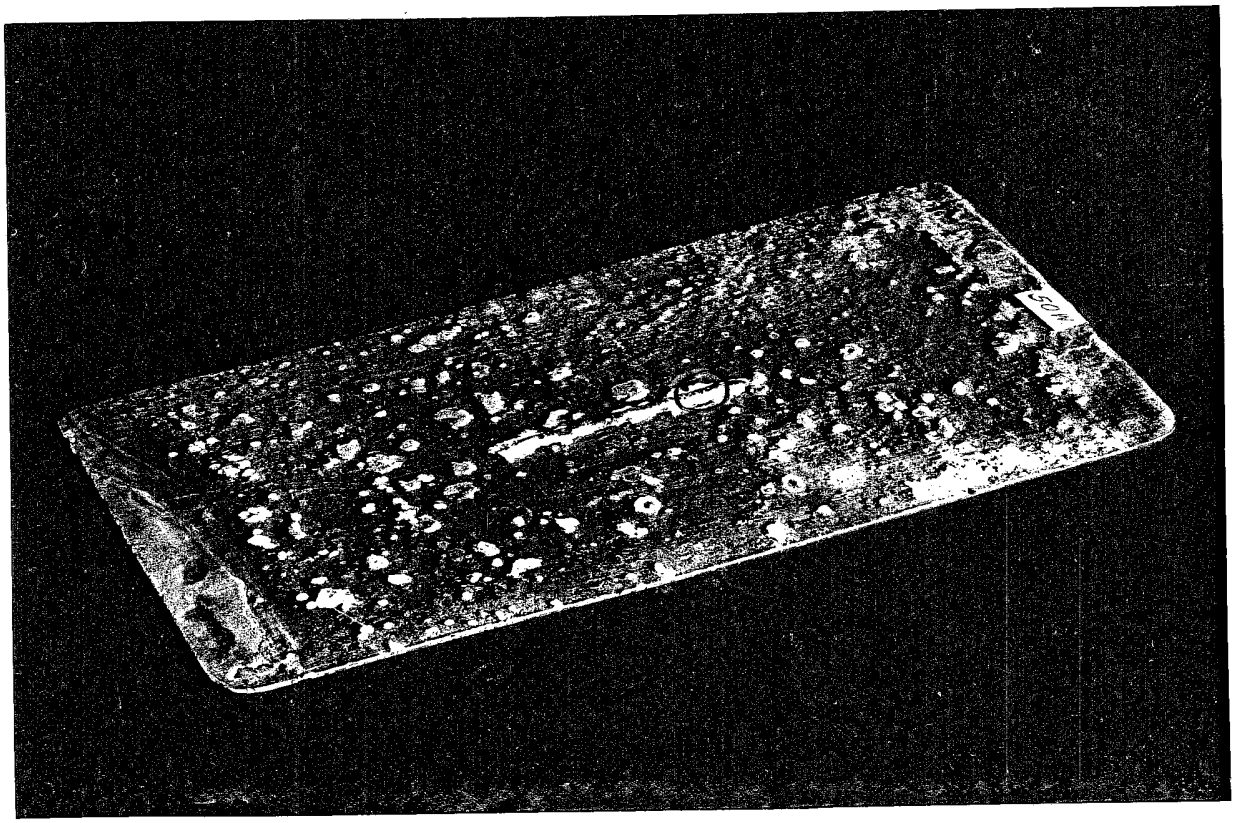
This panel is almost completely pitted.



N39506

Figure 18. Back Side of Monel Panel - 12 Months of Sea-Water Immersion

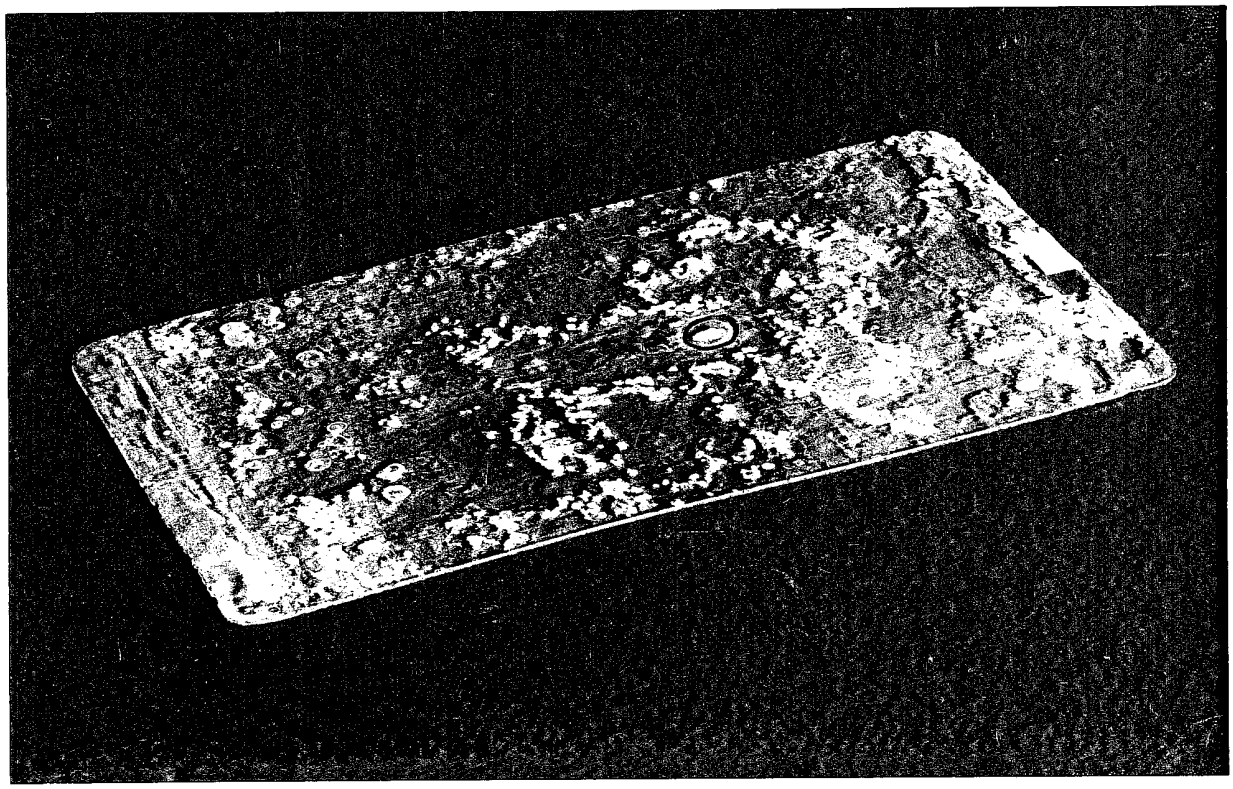
This panel is almost completely pitted.



N39498

Figure 19. Front Side of Monel Panel With Weld Bead (No. 50W) - 12 Months of Sea-Water Immersion

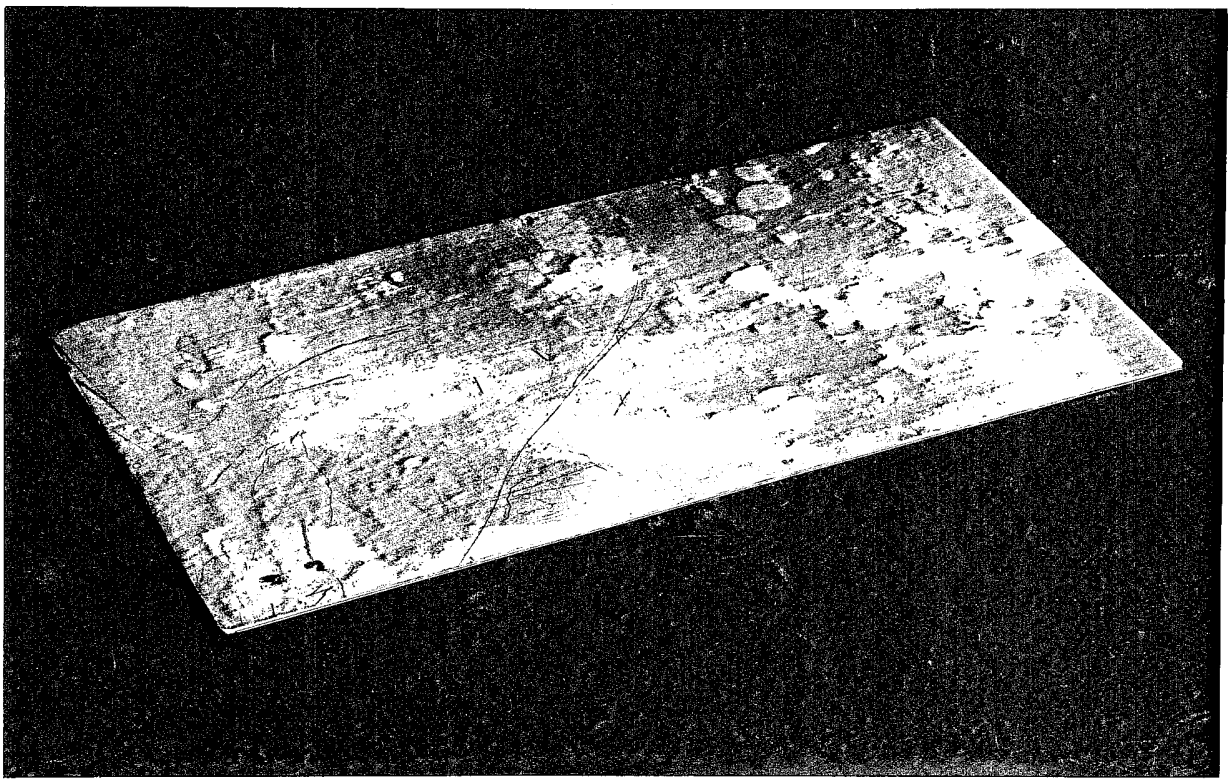
Circled area is pitted completely through panel. Remainder of panel is very badly pitted.



N39505

Figure 20. Back Side of Monel Panel With Weld Bead (No. 5CW) - 12 Months of Sea-Water Immersion

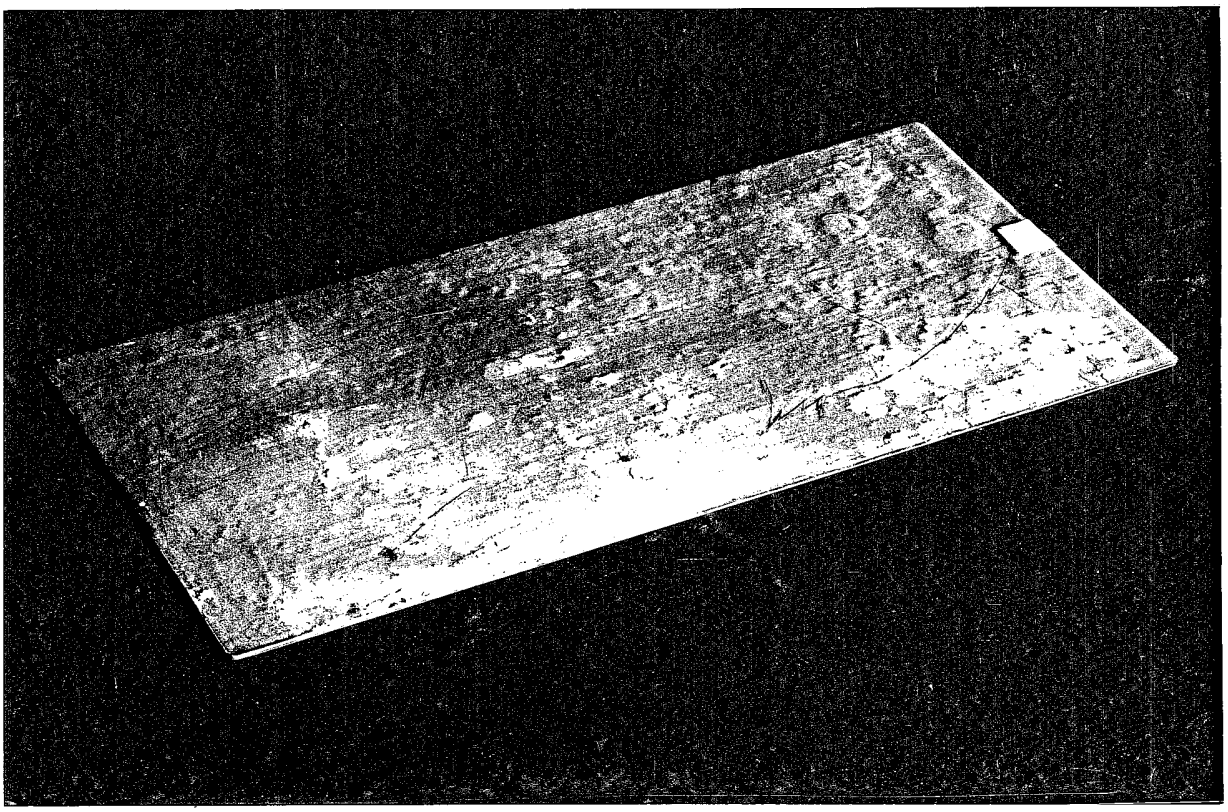
In circled area, penetration is completely through panel. Remainder of panel is badly pitted.



N39504

Figure 21. Front Side of Titanium Panel (No. 60) - 12 Months of Sea-Water Immersion

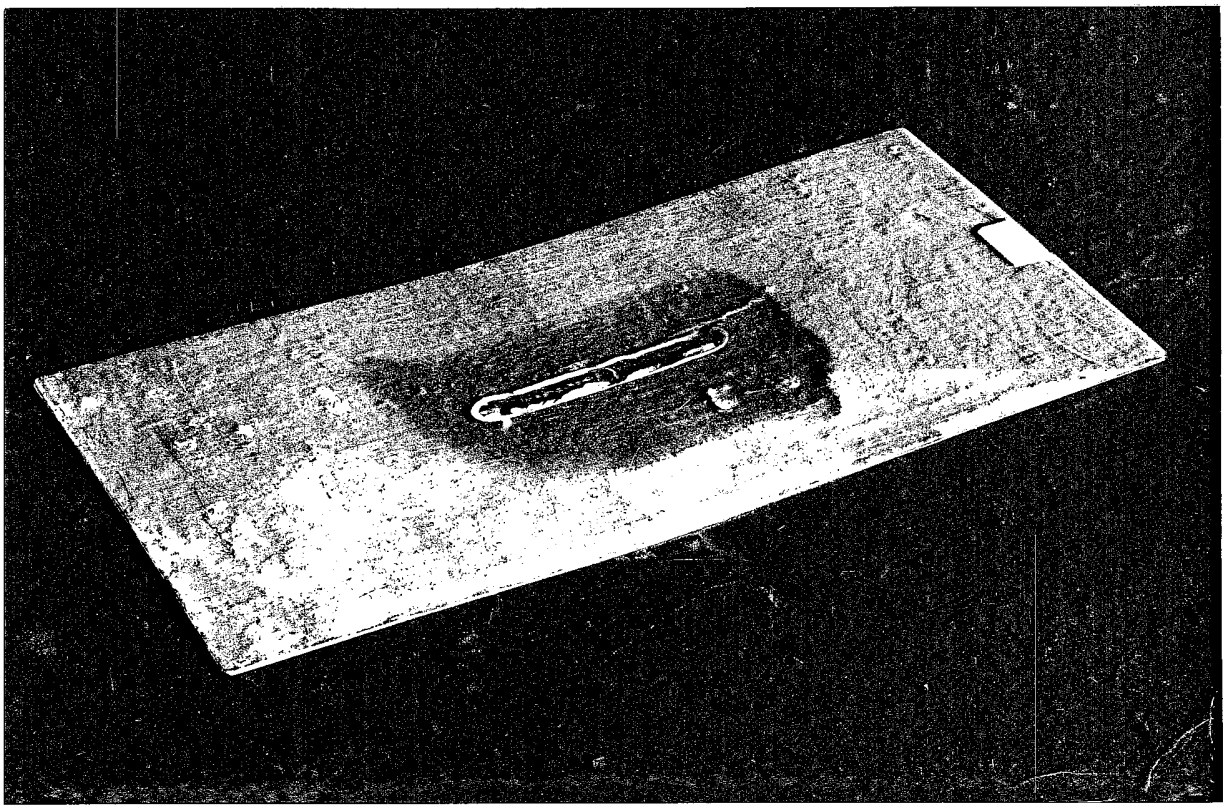
Light spots are areas where marine growth was attached. No evidence of corrosion on any part of panel.



N39501

Figure 22. Back Side of Titanium Panel (No. 60) - 12 Months of Sea-Water Immersion

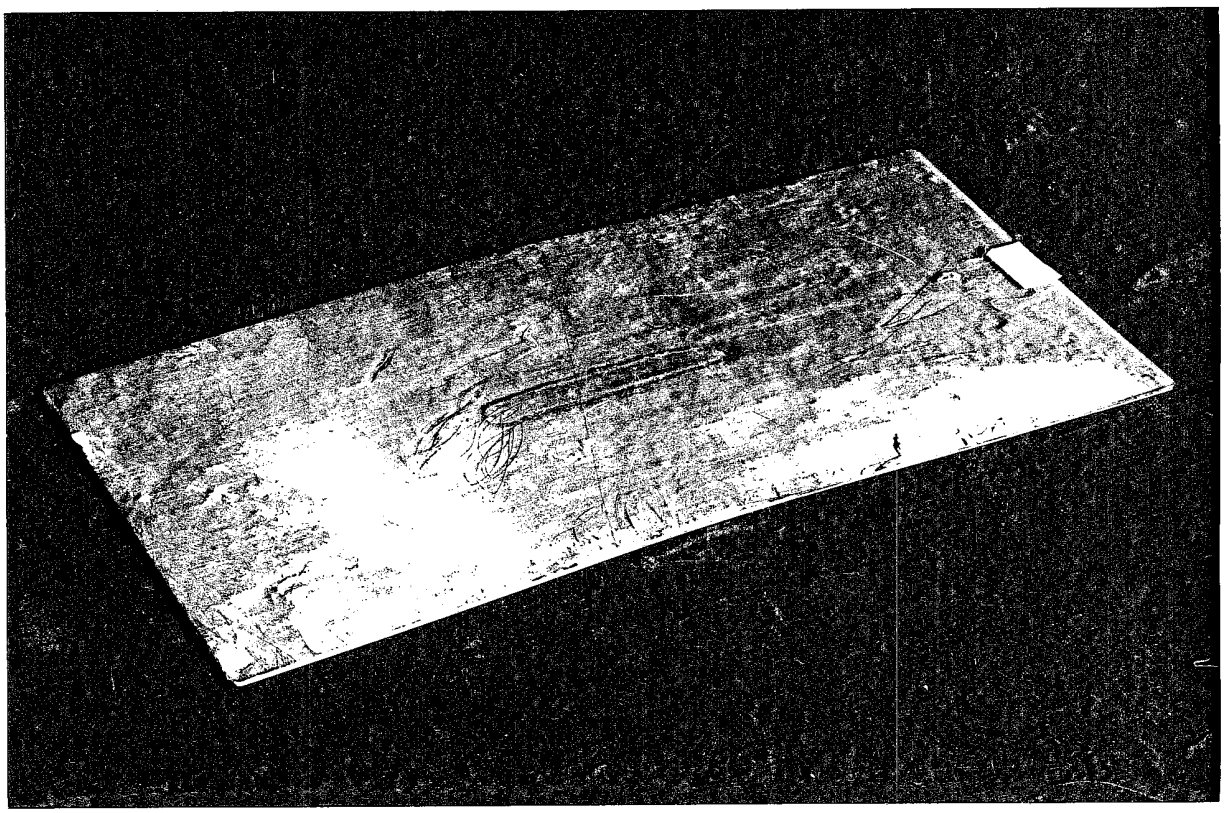
Light spots are areas where marine growth was attached. No evidence of corrosion on any part of panel.



N39500

Figure 23. Front Side of Titanium Panel With Weld Bead (No. 60W) - 12 Months of Sea-Water Immersion

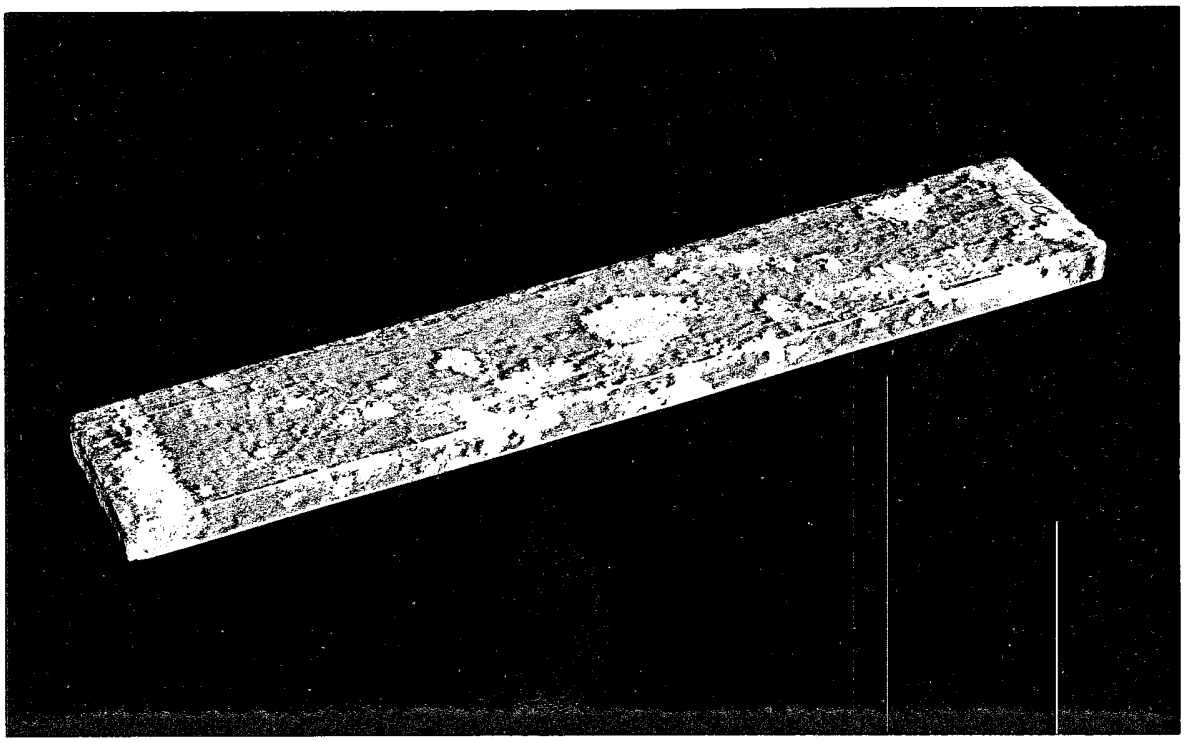
No evidence of corrosion was noted.



N39499

Figure 24. Back Side of Titanium Panel With Weld Bead (No. 60W) - 12 Months of Sea-Water Immersion

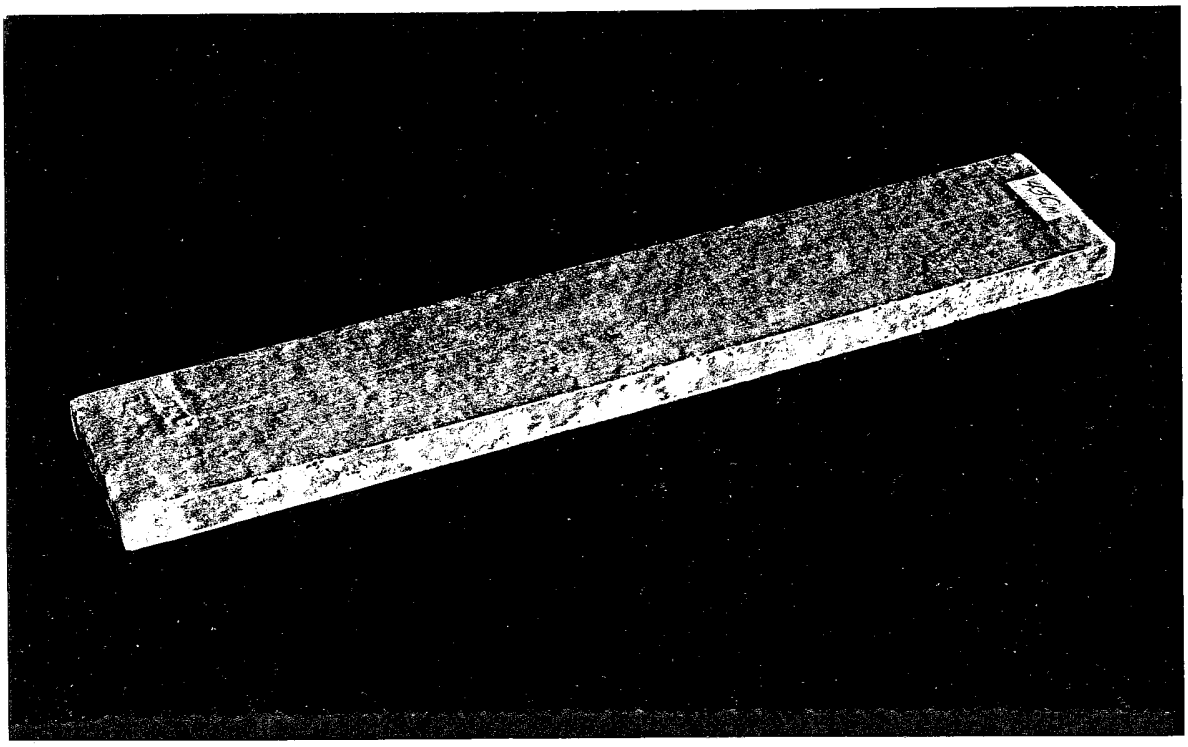
No evidence of corrosion was noted.



N39519

Figure 25. Cast Side of Cast Alloy 43 Panel - 12 Months of Sea-Water Immersion

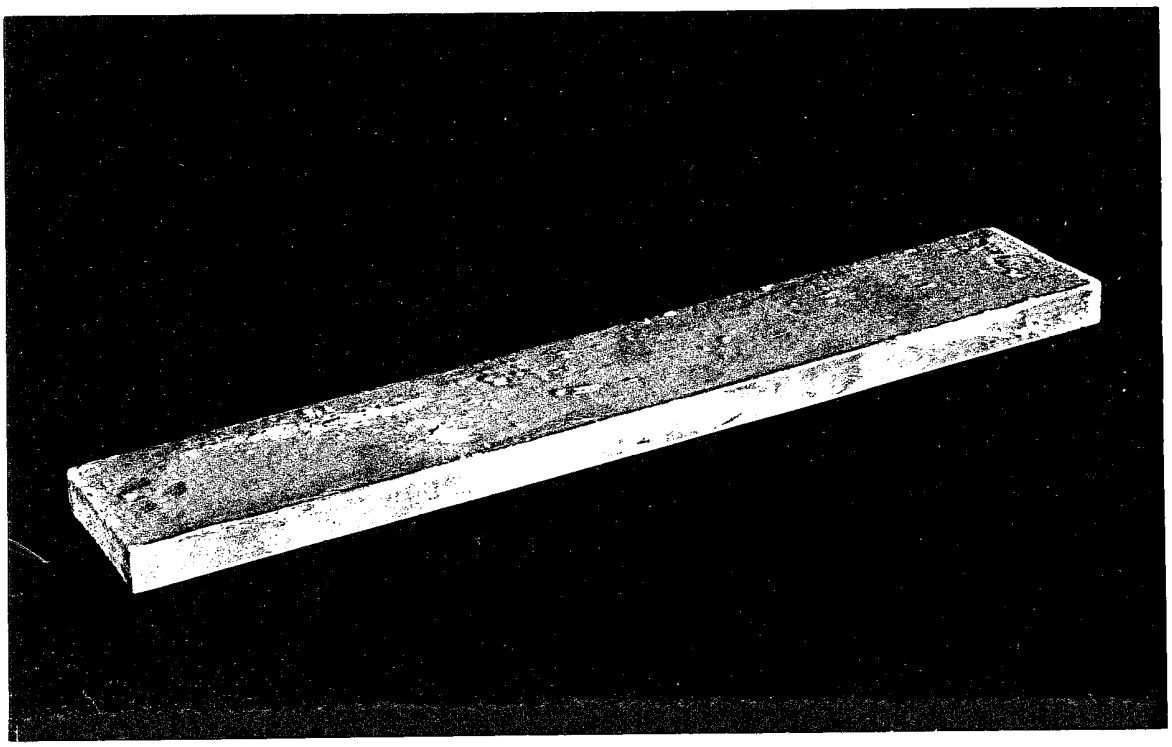
Light areas show minor corrosion damage. Pitting was very shallow.



N39520

Figure 26. Machined Side of Cast Alloy 43 Panel - 12 Months of Sea-Water Immersion

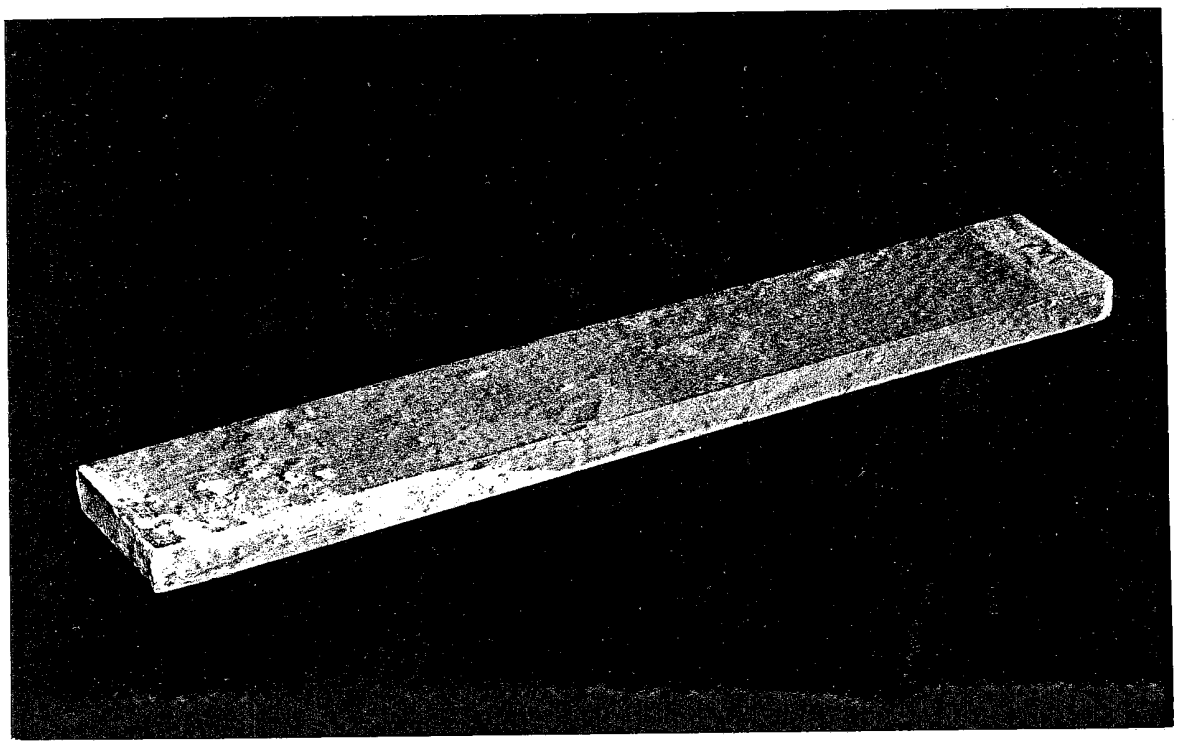
Light areas show minor corrosion damage. Pitting was very shallow.



N39848

Figure 27. Cast Side of Alloy 356-T6 Panel - 12 Months of Sea-Water Immersion

Corrosion pitting was very light.



N39849

Figure 28. Machined Side of Alloy 356-T6 Panel - 12 Months of Sea-Water Immersion

Corrosion pitting was very light.